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EFFECTS OF WINTER MARSH BURNING ON ABUNDANCE AND NESTING ACTIVITY OF LOUISIANA SEASIDE SPARROWS IN THE GULF COAST CHENIER PLAIN

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ABSTRACT.—Louisiana Seaside Sparrows (*Ammodramus maritimus fisheri*) breed and winter exclusively in brackish and saline marshes along the northern Gulf of Mexico. Many Gulf Coast marshes, particularly in the Chenier Plain of southwestern Louisiana and southeastern Texas, are burned intentionally in fall or winter as part of waterfowl management programs. Fire reportedly has negatively affected two Seaside Sparrow subspecies (*A. m. nigrescens* and *A. m. mirabilis*) in Florida, but there is no published information regarding effects of fire on *A. m. fisheri.* We compared abundance of territorial male Louisiana Seaside Sparrows, number of nesting activity indicators, and vegetation structure in paired burned and unburned plots in Chenier Plain marshes in southwestern Louisiana during the 1996 breeding season (April–July) before experimental winter burns (January 1997) and again during two breeding seasons post-burn (1997–1998). We found that abundance of male sparrows decreased in burned plots during the first breeding season post-burn, but was higher than that of unburned plots during the second breeding season post-burn. Indicators of nesting activity showed a similar but non-significant pattern in response to burning. Sparrow abundance and nesting activity seemingly are linked to dead vegetation cover, which was lower in burned plots during the first breeding season post-burn, but did not differ from that in unburned plots during the second breeding season post-burn. We recommend that marsh management plans in the Gulf Coast Chenier Plain integrate waterfowl and Seaside Sparrow management by maintaining a mosaic of burned and unburned marshes and allowing vegetation to recover for at least two growing seasons before re-burning a marsh. *Received 16 Sept. 1999, accepted 10 April 2000.*

The Seaside Sparrow (*Ammodramus maritimus*) breeds and winters exclusively in coastal brackish and saline marshes along the Atlantic and Gulf coasts of the United States (Robbins 1983, Post and Greenlaw 1994). This species presently is considered a "non-game migratory species of management concern" throughout much of its breeding range because of habitat loss and alteration (Greenlaw 1992). Two non-migratory subspecies, the Dusky Seaside Sparrow (*A. m. nigrescens*) and Smyrna Seaside Sparrow (*A. m. pelonata*), were sensitive to human-induced habitat changes and now are extinct (Post and Greenlaw 1994). Coastal marsh loss and degradation have been dramatic in recent years, particularly in the Gulf Coast region (Boesch et al. 1983, Alexander et al. 1986, Cowan et al. 1988). Information regarding responses of Seaside Sparrow subspecies to habitat alteration is necessary to properly manage and maintain suitable habitat for this endemic coastal marsh bird.

Louisiana Seaside Sparrows (*A. m. fisheri*), the most widely distributed non-migratory subspecies, inhabit coastal marshes from western Florida to southeastern Texas (Robbins 1983, Post and Greenlaw 1994). The year-round distribution includes the Gulf Coast Chenier Plain, a narrow 1295 km^2 band of coastal marsh extending from Vermilion Bay, Louisiana to East Bay, Texas (Gosselink 1979, Robbins 1983, Post and Greenlaw 1994). Lightning fires occur frequently in these marshes, usually between June and August (Lynch 1941). In addition, marsh managers in this region commonly use fall or winter burns to alter plant communities and promote food plants preferred by muskrats (*Odantra zibethicus*) and waterfowl (Nyman and Chabreck 1995).

Lightning and human ignited fires reportedly have been both detrimental and beneficial to two non-migratory Seaside Sparrow subspecies. The number of singing Dusky Seaside Sparrow males was reduced by half in the breeding season immediately following two extensive wildfires in a single winter as the result of a lack of suitable cover and direct

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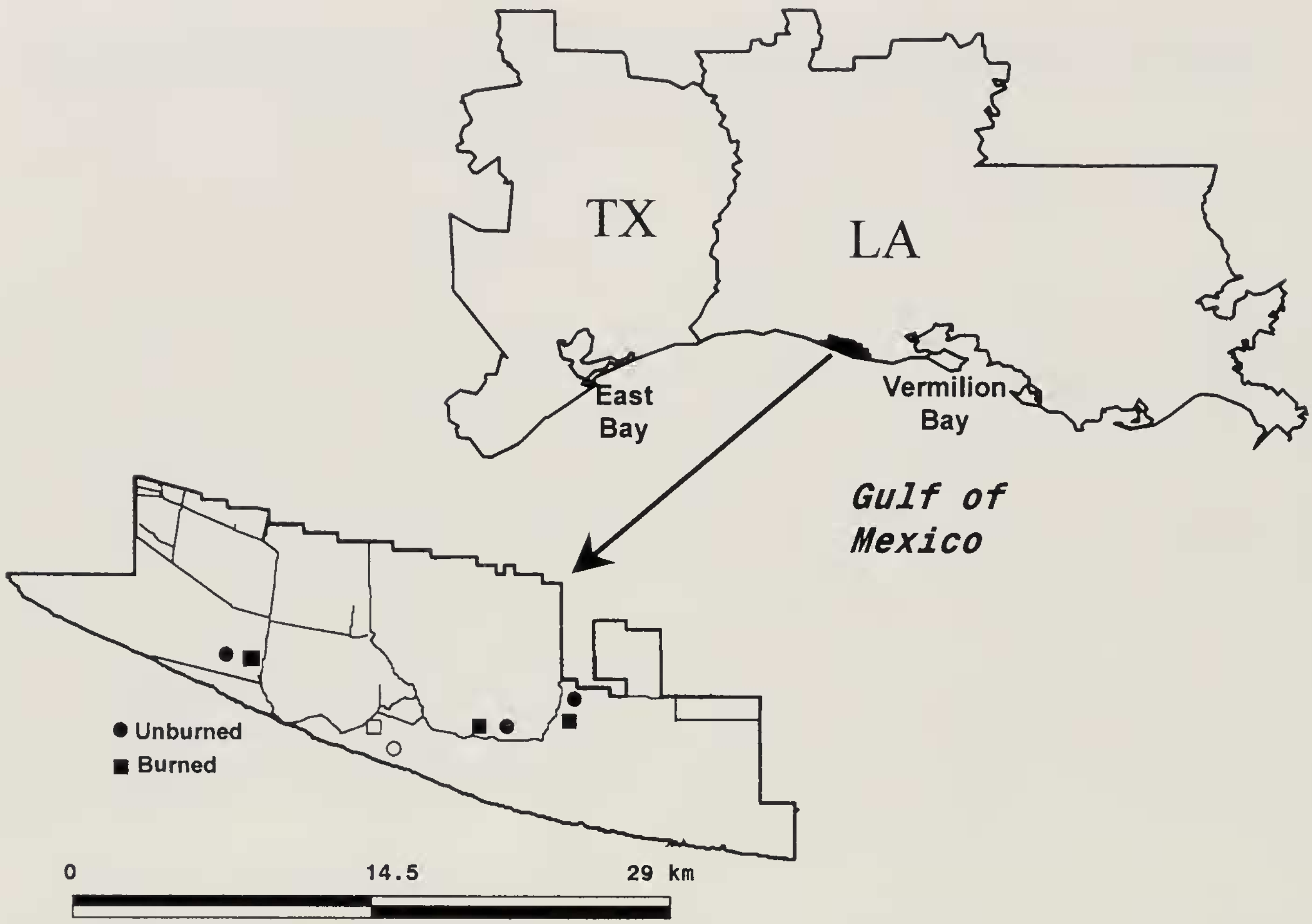

FIG. 1. Map of southern Louisiana and southeastern Texas showing locations of Rockefeller State Wildlife Refuge and four pairs of burned and unburned plots. Solid lines within the refuge boundary represent major levees. Solid and empty symbols indicate plots in brackish and saline marsh, respectively. Squares represent plots burned in January 1997; circles represent unburned plots.

mortality (Baker 1973, 1978; Walters 1992). In contrast, Sykes (1980) argued that fire was essential in maintaining Dusky Seaside Sparrow habitat because it removed woody vegetation and decreased vegetation density. Frequent human induced fires have been cited as a major threat to Cape Sable Seaside Sparrows (*A. m. mirabilis*) in southern Florida (Kushlan and Bass 1983). Cape Sable Seaside Sparrows generally were absent from marshes burned during the previous winter (Taylor 1983). Density of this subspecies, however, increased between two and four years post-burn and then declined, suggesting that periodic fire is necessary to maintain suitable habitat (Taylor 1983, Post and Greenlaw 1994). Effects of management burns on Louisiana Seaside Sparrows are unknown but could be significant, given the apparent vulnerability of several subspecies to habitat alteration. We compared abundance of territorial male Louisiana Seaside Sparrows, number of nesting activity indicators, and vegetation structure in paired burned and unburned plots in Chenier Plain marshes in southwestern Louisiana during the 1996 breeding season (April–July) before experimental winter burns (January 1997) and again during two breeding seasons post-burn (1997–1998). We predicted that responses of Louisiana Seaside Sparrows to winter burning would be similar to that of Cape Sable Seaside Sparrows (Taylor 1983); that is, the abundance of male Louisiana Seaside Sparrows and nesting activity in burned marshes would be lower than those in unburned marshes during the first breeding season after the burn, but these parameters would be equal to or greater in burned marshes than in unburned marshes in the second breeding season.

METHODS

Study area.—We chose Rockefeller State Wildlife Refuge (SWR) in southwestern Louisiana as a representative area within the Gulf Coast Chenier Plain (Fig. 1). Rockefeller SWR (headquarters coordinates: 29° 40′ N, 92° 48′ W) is a 30,700 ha area managed primarily as winter waterfowl habitat by the Louisiana

Department of Wildlife and Fisheries. Rockefeller SWR consists of 17 impoundments ranging in size from 200 to more than 4000 ha (Wicker et al. 1983) and approximately 11,700 ha of tidally influenced unimpounded marshes. Most impoundments were constructed during the late 1950s and are separated by a network of canals. Management burns on Rockefeller SWR are conducted on a 3 year rotation, with approximately one-third of the refuge area burned during a single fall/winter (October–February). Lightning-ignited fires occur on Rockefeller SWR from June–August (0–3 fires/year during 1993–1995; T. J. Hess, unpubl. data).

Marsh types on Rockefeller SWR include a band of saline marsh along the Gulf Coast, a band of brackish marsh further inland, and intermediate marsh still further inland (Chabreck 1970, Chabreck and Linscombe 1988). Saline marsh (salinity ≥ 10 ppt) is dominated by *Spartina alterniflora, S. patens,* and *Distichlis spicata.* Brackish marsh (5–10 ppt) is characterized by *S. patens, D. spicata,* and *Scirpus* spp. Intermediate marsh (1–5 ppt) is dominated by *Spartina patens* (Chabreck 1970, 1972; Chabreck and Linscombe 1988). Impounded marshes in our study were brackish; unimpounded marshes were exposed to tidal action of the Gulf and were brackish or saline. We did not use intermediate or fresh (salinity < 1 ppt) marshes because Louisiana Seaside Sparrows were absent from these marsh types (Gabrey 1999, Gabrey et al. 1999). Virtually all vegetation was herbaceous within our study area (Gabrey 1999).

Using vegetation-type and fire-history maps of Rockefeller SWR, we selected study sites that met the following criteria: (1) minimum area of 100 ha, (2) presence of a firebreak (bayou, canal), (3) homogeneous marsh type and fire history within the site, (4) site accessibility, and (5) absence of other research projects or physical structures potentially damaged by fire. Four sites met these criteria: two in brackish impoundments and one each in unimpounded saline and unimpounded brackish marsh (Fig. 1). At each site, we established paired 250 × 250 m plots (6.25 ha each), one on each side of the firebreak. Plots were gridded at 25-m intervals (Petersen and Best 1987). One plot at each site was chosen randomly to be burned between 9–18 January 1997; control plots remained unburned throughout the study. We collected bird and vegetation data (see below) during the 1996 breeding season (April–July) prior to burning and during two breeding seasons post-burn (1997–1998).

Sparrow surveys.—We recorded abundance of male Louisiana Seaside Sparrows in study plots using the spot-mapping method (Ralph et al. 1993). Two experienced observers conducted surveys each year with one observer present for all three years. Paired plots were surveyed simultaneously (one observer/plot). To reduce potential observer bias, observers alternated between plots at each site during consecutive sampling periods. The starting point for each survey rotated among four points (one on each side of the plot). Surveys were completed within 4 h of sunrise. In 1997 and 1998, we surveyed plots 11 times from April–July, once during every 10-day interval (International Bird Census Committee 1970). Low water levels from a severe drought in April–May 1996 prevented more frequent access to plots; consequently we surveyed plots 8 times during the 1996 breeding season, once during the first two weeks of each month and once during the last two weeks.

During each survey, the observer walked slowly along every other grid line within the plot and recorded on a field map locations and flight directions (to reduce double-counting) of all males (determined by singing or territorial behavior) encountered. We did not use spot-map locations to determine territory boundaries because (1) territory size varies temporally (Best 1975), (2) individuals were spaced closely, resulting in subjective measurements (International Bird Census Committee 1970, Best 1975), (3) off-territory feeding is common in this species (Post 1974), and (4) males often moved to only one or two perches before flying beyond plot boundaries or into vegetation (S. W. Gabrey, pers. obs.).

Nesting activity.—We used nesting activity indicators (nests, copulation events, adult birds carrying food or nesting material, or flightless juveniles) to index Louisiana Seaside Sparrow productivity because of the difficulty in locating nests in dense vegetation and concern for investigator-induced nest failure. We recorded all nesting activity observed during surveys of male sparrows. In addition, beginning in May 1996, we conducted 1 h nesting activity searches before and after each survey. The observer walked along those grid lines not used during surveys and recorded all observed nesting activity. We plotted locations of nesting activity on field maps to avoid double counting.

Vegetation characteristics.—We collected vegetation data at 12 randomly selected points in each plot during the first week of June each year. We measured visual obstruction (an index to plant height) following methods described by Robel and coworkers (1970). Percent total vegetation cover (all plant species combined) and percent dead vegetation cover at each point were determined by laying a 1 m pole marked at 0.1 m intervals on the ground, and determining the percent of the pole covered (Chabreck et al. 1985). Cover classes were 7 (76–100%), 6 (51–75%), 5 (26–50%), 4 (6–25%), 3 (1–5%), 2 (few stems), 1 (single stem), and 0 (absent; Mueller-Dambois and Ellenberg 1974). To calculate mean values for categorical data, we converted cover classes to a discrete response using the midpoint of the class [i.e., Class 7 = 87.5%, Class 6 = 62.5%, Class 5 = 37.5%, Class 4 = 15%, Class 3 = 2.5%, and Classes 1 and 2 = 0.5% (Agresti 1996, Pahl et al. 1997)]. Sample points located in a pond or unvegetated mud were given visual obstruction and cover scores of 0. We calculated the mean visual obstruction score, mean total cover midpoint, and mean percent dead vegetation cover midpoint for each plot.

Breeding site fidelity.—We used mist nets to capture and band Seaside Sparrows in two of the four pairs of burned-unburned plots to estimate site fidelity in response to burning. We placed 3–7 nets (6 or 12 m × 2 m × 36 mm mesh) in a line along a grid line, and 2–5 workers attempted to flush sparrows into the nets by walking towards the nets. We aged captured sparrows as adult or juvenile using plumage characteristics and sexed sparrows based on presence of a brood patch or cloacal protuberance (Pyle et al. 1991). Sparrows were fitted with an aluminum USFWS band and 1–3 colored leg bands. In 1996, we used one or two colored bands to identify age, sex, and plot where captured. In 1997, each sparrow received a unique combination of bands to facilitate individual recognition. We did not capture sparrows in 1998. We defined net-hours as the number of 6 m nets (12 m nets were counted as two nets) times the number of hours spent trapping. We recorded capture, resight, and recapture locations on field maps.

Analysis.—We analyzed pre-burn (1996) data separately from post-burn data (1997, 1998) because the first year was a pilot year in which study protocols were developed and because sampling effort differed from post-burn years (see above). For pre-burn data, we compared male Louisiana Seaside Sparrow abundance using a repeated measures analysis of variance (ANOVA) with burn treatment (burned or unburned) as the explanatory variable and survey period (1–8) as the repeated measure. We compared nesting activity indicators, visual obstruction scores, percent total vegetation cover, and percent dead vegetation cover using single-factor ANOVAs with burn treatment as the explanatory variable.

For post-burn data, we compared male Louisiana Seaside Sparrow abundance using a repeated measures analysis of variance with burn treatment as the explanatory variable, and year (1997, 1998) and survey period (1–11) as repeated measures. We analyzed post-burn nesting activity indicators and vegetation response variables (visual obstruction, percent total vegetation cover, and percent dead vegetation cover) with a model similar to that used for male sparrow abundance, except that survey period was excluded from the model.

In all analyses, we made pairwise comparisons when necessary (using the PDIFF option in the LSMEANS statement in PROC GLM; SAS Institute 1990). Because plots were located in impounded and unimpounded marshes, we included management type (impounded or unimpounded) as a block effect in all ANOVAs. We transformed [$\log_{10}(Y + 1)$] male Louisiana Seaside Sparrow abundance, nesting activity indicators, and visual obstruction scores to meet assumptions for parametric procedures (Sokal and Rohlf 1981). We report least-squares means and 95% confidence intervals as back-transformed values unless otherwise indicated. Only four sites were available at Rockefeller SWR that met our selection criteria; consequently, we set *a priori* a significance level of 0.10 because of low statistical power (Cohen 1977). Because the three vegetation characteristics represent multivariate measurements taken at a single point, we adjusted the significance level for vegetation analyses (but not sparrow analyses) by dividing the original significance level (0.10) by the number of hypotheses tested (3) for an adjusted significance level of 0.033 (Beal and Khamis 1991, Johnson and Wichern 1992). All analyses were performed with software SAS/STAT version 6 for Windows 95.

RESULTS

Pre-burn analysis.—The number of Louisiana Seaside Sparrow males observed during 1996 breeding season surveys did not differ between control plots and those randomly selected to be burned ($F_{1,47} = 0.94$, $P > 0.10$) or among survey periods ($F_{7,47} = 1.29$, $P > 0.10$). The burn × survey period interaction also was not significant ($F_{7,47} = 0.35$, $P > 0.10$). The overall mean number of male sparrows observed/survey was 11.9 (95% CI = 10.0–14.2). Number of nesting activity indicators/plot in 1996 (3.3 indicators/plot, 95% CI = 1.3–7.0) also did not differ between control plots and those randomly selected to be burned ($F_{1,5} = 0.25$, $P > 0.10$).

Visual obstruction scores ($F_{2,5} = 0.32$, $P > 0.033$; overall mean = 7.5; 95% CI = 6.0–9.3), percent total vegetation cover ($F_{2,5} = 3.70$, $P > 0.033$; overall mean = 76.6%; 95% CI = 65.8–87.5) and percent dead vegetation cover ($F_{2,5} = 1.65$, $P > 0.033$; overall mean = 80.2%; 95% CI = 69.5–91.0) during June 1996 did not differ between control plots and those randomly selected to be burned in January 1997.

Post-burn analysis.—Our initial analysis of post-burn abundance of male Louisiana Seaside Sparrows indicated a burn × survey period × year interaction ($F_{21,131} = 4.22$, $P < 0.01$). We were interested primarily in within year differences in male abundance; consequently, we conducted separate ANOVAs for 1997 and 1998 to examine burn × survey period interactions. For 1997, we detected a burn × survey period interaction ($F_{10,65} = 4.15$, $P < 0.01$). Abundance of male Louisiana Seaside Sparrows was lower in burned than in unburned control plots for the first five surveys of 1997 but similar thereafter, except for 1–10 July (Fig. 2). For 1998 data, the burn × survey period interaction was not significant ($F_{10,65} = 0.72$, $P > 0.10$); however, the burn ($F_{1,65} = 27.04$, $P < 0.01$) and period ($F_{10,65} = 2.61$, $P < 0.01$) main effects were significant. Male sparrow abundance was higher in burned (15.8 males/survey; 95% CI = 13.1–

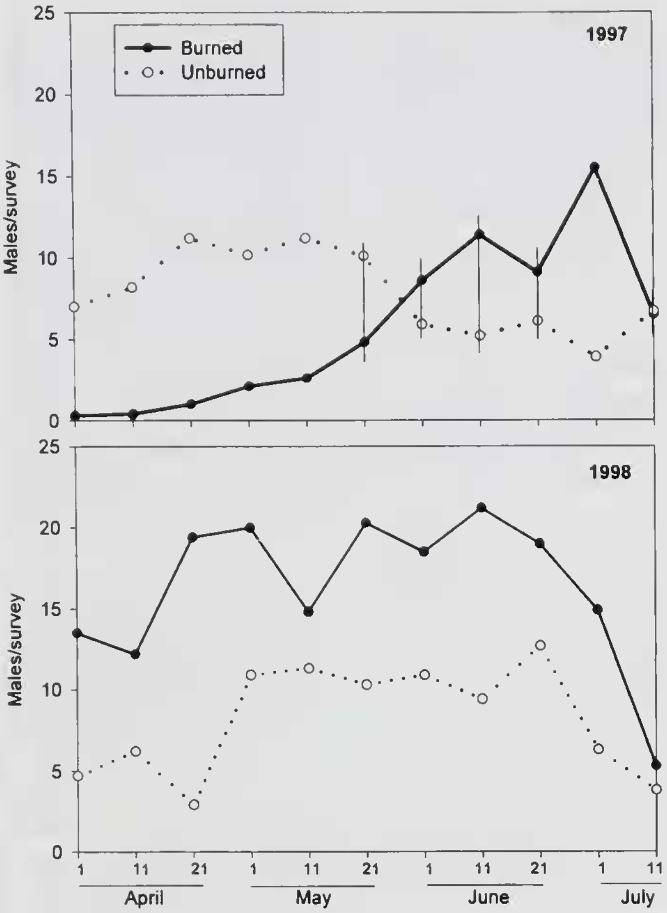

FIG. 2. Number of male Louisiana Seaside Sparrows recorded during April–July in paired burned and unburned plots on Rockefeller State Wildlife Refuge during 1997 (top) and 1998 (bottom). Experimental burns were conducted in January 1997. Points connected with vertical lines are not significantly different ($P > 0.10$).

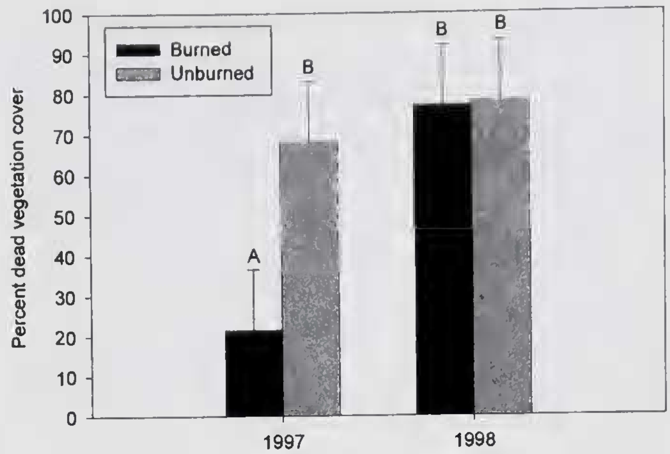

FIG. 3. Percent dead vegetation cover in paired burned and unburned plots on Rockefeller State Wildlife Refuge during June 1997–1998. Experimental burns were conducted in January 1997. Error bars represent upper 95% confidence limits. Similar letters above bars indicate that means do not differ ($P > 0.033$).

19.0) than in unburned (7.5 males/survey; 95% CI = 5.7–9.6) control plots throughout the 1998 breeding season. Male sparrow abundance generally was highest during May and June 1998 for all plots (Fig. 2).

In 1997, we recorded 2.0 (95% CI = 0.3–3.7) and 4.3 (95% CI = −1.5–10.1) nesting activity indicators/plot in burned and unburned plots, respectively. In 1998, we recorded 10.0 (95% CI = 6.5–13.5) and 8.0 (95% CI = 3.0–13.0) nesting activity indicators/plot in burned and unburned plots, respectively. The burn × year interaction ($F_{1,11} = 0.60$, $P > 0.10$) and burn main effect ($F_{1,11} = 0.02$, $P > 0.10$) were not significant. Number of nesting activity indicators/plot was higher ($F_{1,11} = 10.41$, $P < 0.01$) in 1998 (8.2 indicators/plot; 95% CI = 4.6–14.0) than in 1997 (2.1 indicators/plot; 95% CI = 0.9–4.1).

Visual obstruction scores did not differ between burn treatments ($F_{1,15} = 0.38$, $P > 0.033$) or year ($F_{1,15} = 0.55$, $P > 0.033$); the burn × year interaction also was not significant ($F_{1,15} = 0.25$, $P > 0.033$). Overall mean visual obstruction score was 7.4 (95% CI = 6.1–8.9). Percent total vegetation did not differ between burn treatments ($F_{1,15} = 0.01$, $P > 0.05$) or year ($F_{1,15} = 2.39$, $P > 0.033$); the burn × year interaction also was not significant ($F_{1,15} = 1.03$, $P > 0.033$). Overall mean percent total vegetation cover was 79.5% (95% CI = 73.3–85.7). We detected a significant year × burn interaction in the analysis of percent dead vegetation cover ($F_{1,15} = 11.44$, $P < 0.01$). In 1997, percent dead vegetation cover was lower in burned than in unburned plots but did not differ between burn treatments in 1998; percent dead vegetation cover in burned plots was lower in 1997 than in 1998 (Fig. 3).

Breeding site fidelity.—We banded 115 (73 in 1996, 42 in 1997) Seaside Sparrows during 290 net-hours in two burned and two unburned plots. We spent little time netting in burned plots in 1997 because our surveys indicated that sparrows were not present in those two plots throughout much of 1997. All encounters (resightings or recaptures) were of sparrows banded as adults and were in the plots in which they initially were caught. In 1997, we recaptured 3 of 27 adult sparrows banded in unburned plots in 1996, all within 100 m of the location of initial capture. On five occasions in 1997, we resighted at least two adult sparrows in the same unburned plots in which they had been banded in 1996. In contrast, in 1997 we resighted 1 and recaptured none of 35 adult sparrows banded in burned plots in 1996. In 1998, we resighted 7 of 38 adult sparrows banded in unburned plots in 1997; no birds banded in 1996 were encountered in unburned plots in 1998. In burned plots, however, we resighted at least one sparrow banded in 1996 on two occasions in a single burned plot but did not recapture any.

DISCUSSION

We found that none of our response variables differed between control and experimental plots during the 1996 breeding season (April–July) prior to burning in January 1997. Consequently, we assume that differences observed during the two post-burn breeding seasons (1997, 1998) primarily resulted from our experimental winter burns.

We found that abundance of male Louisiana Seaside Sparrows was reduced markedly during the first breeding season post-burn (1997) but nesting activity showed no significant decline in burned plots compared to unburned plots. We believe that Louisiana Seaside Sparrows present in our experimental plots prior to burning moved to nearby unburned marsh after the fire because (1) direct mortality of birds from fire occurred infrequently (Whelan 1995, but see Walters 1992) and (2) non-migratory populations of Seaside Sparrows stay in or near the breeding territory throughout the year and usually breed in the same territory in consecutive years (Post and Greenlaw 1994), a behavior supported by our observations of banded sparrows in unburned plots. Such displacement could affect short-term reproductive success by forcing dispersal into habitats of poorer quality, increasing population density in good quality habitats, interfering with pair bonds or mate fidelity, or delaying territory establishment or nesting activity (Best 1979, Taylor 1983).

We found that declines in male abundance and nesting activity during the first breeding season post-burn were temporary. A similar pattern of initial post-burn decline and subsequent population increase associated with plant succession was suggested for Cape Sable Seaside Sparrows (Taylor 1983). Louisiana Seaside Sparrows nest in low vegetation and may require a minimum amount of ground cover that was not attained until the second summer after burning as suggested for Vesper Sparrows (*Pooecetes gramineus*; Petersen and Best 1987). The dominant vegetation in our study area, *Spartina patens,* usually is erect in the early growth stages, but after reaching a height of about 1 m it falls over, creating a low (<1 m) closed canopy. This canopy, composed of live and dead *S. patens,* was reestablished by the second summer after burning (S. W. Gabrey, pers. obs.), coinciding with high Louisiana Seaside Sparrow abundance in burned plots.

Percent dead vegetation cover in burned plots was 50% less than in unburned plots the first breeding season after burning (1997) when Louisiana Seaside Sparrow abundance was low. In 1998, percent dead vegetation cover in burned plots recovered to pre-burn levels; this increase coincided with the increase in Louisiana Seaside Sparrow abundance. Thus, the amount of dead vegetation seemingly affects Louisiana Seaside Sparrow abundance and nesting activity in our study area. Seaside Sparrows feed primarily on invertebrates gleaned off the ground or low vegetation (Post and Greenlaw 1994); litter and dead vegetation may act as a substrate for invertebrate prey. In addition, Louisiana Seaside Sparrows use mostly dead vegetation for nest construction (S. W. Gabrey, pers. obs.); thus, burning may reduce availability of nesting material.

Sykes (1980) and Taylor (1983) emphasized the importance of properly timed fires to restore habitat for Dusky Seaside Sparrows and Cape Sable Seaside Sparrows in Florida. Our results indicate that periodic fire is an important factor affecting Louisiana Seaside Sparrow population size and nesting activity. Because one year apparently must pass before vegetation structure in burned marsh recovers to levels suitable for breeding Louisiana Seaside Sparrows, burning a marsh more frequently than every two winters will likely have detrimental effects on local sparrow populations, especially if no suitable unburned "refugia" habitat was located nearby. Consequently, we recommend that marsh managers maintain a mosaic of marshes of varying post-burn ages, including parcels of at least two years post-burn, to integrate waterfowl and Louisiana Seaside Sparrow management in Gulf Coast marshes. Local vegetation, soil characteristics, hydrology, natural fire regime, and other factors likely will determine the practicality and effectiveness of burning for Seaside Sparrow management in other parts of the breeding range.

Taylor (1983) suggested that after 5–10 years without burning, the density of dead vegetation and ground litter increases beyond suitable levels for Cape Sable Seaside Sparrows. We do not know at which point unburned marshes in the Chenier Plain will become unsuitable for Louisiana Seaside Sparrows but other studies (Gabrey 1999) suggest that sparrow abundance declined in the third year post-burn. Long-term studies of sparrow abundance and productivity would provide useful information regarding ideal burning rotations in the Chenier Plain. Comparative studies of managed burns of different frequencies or seasonality with natural lightning fires would help our understanding of the role of fire in the conservation of coastal marsh birds.

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